Energy, Mines and Resources Canada | Energie, Mines et Ressources Canada

CANMET

Canada Centre for Mineral and Energy Technology | Centre canadien de la technologie des minéraux et de l'énergie

USE OF SMALL MAMMALS FOR BIOMONITORING ENVIRONMENTAL RADIONUCLIDE LEVELS AROUND URANIUM MINING INDUSTRIES

N.R. CLOUTIER, T.P. LIM AND N.K. DAVE

ELLIOT LAKE LABORATORY

AUGUST 1984

This document ... (CANMET)

... rapport ... non révisé et rédigé ... pour ... de ... document ... représente ... l'expression définitive de ... du Centre canadien de la technologie des minéraux et de l'énergie (CANMET)

OCT 26 1984

MICROMEDIA

10 pp

MINERALS RESEARCH PROGRAM
MINING RESEARCH LABORATORIES
DIVISION REPORT MPR/MRL 84-80 (TR)

85-0258/

USE OF SMALL MAMMALS FOR BIOMONITORING ENVIRONMENTAL RADIONUCLIDE LEVELS AROUND URANIUM MINING INDUSTRIES

by
N.R. Cloutier*, T.P. Lim** and N.K. Dave+

ABSTRACT

The use of small mammals for monitoring radionuclide levels in the environment near uranium tailings and open pit uranium mines is explored. The use of three species is suggested: the meadow vole for monitoring grassy habitats (i.e., revegetated tailings), and both the deer mouse and red-backed mouse for monitoring forested areas (i.e., forests around open pit mines and tailings).

---

*Technician, ** Physical Scientist, +Research Scientist, Elliot Lake Laboratory, CANMET, Energy, Mines and Resources, Elliot Lake, Ontario.

UTILISATION DE PETITS MAMMIFÈRES POUR LA BIOSURVEILLANCE DES NIVEAUX DE RADIONUCLÉIDES AUX ENVIRONS DES EXPLOITATIONS MINIÈRES D'URANIUM

par

N.R. Cloutier*, T.P. Lim** et N.K. Dave*

RÉSUMÉ

Le présent résumé a trait à l'utilisation de petits mammifères pour la surveillance des niveaux de radionucléides dans les environs des décharges de résidus d'uranium et des exploitations minières à ciel ouvert. On suggère l'utilisation de trois espèces de mammifères: le campagnol des champs, pour la surveillance des habitats herbeux (i.e., les zones de résidus recouvertes de végétation) ainsi que le chevrotain et le campagnol à dos roux pour la surveillance des régions boisées (i.e., les forêts entourant les exploitations à ciel ouvert et les décharges de résidus d'uranium).

---

*Technicien, **Chercheur en sciences physiques, Laboratoire d'Elliot Lake, CANMET, Énergie, Mines et Ressources, Elliot Lake Ontario.

INTRODUCTION

Methods of monitoring the presence of potentially harmful elements in the environment are receiving increasing attention: accumulation by moss-bags, lichens and tree bark have been examined (1-7). Since these methods do not assess the hazard of a potential harmful element to wildlife or grazing livestock, some researchers have turned towards the use of small mammals for biological monitoring . Beardsley et al (8) have reported that the response of voles (M. agrestis) to metal pollution was too small and too erratic for it to be suitable. On the other hand, Rowley et al (9) have reported that the presence of organic hazardous compounds in the environment could be detected using voles (M. pennsylvanicus) as a monitoring species. Furthermore, we have previously reported accumulations of radionuclide (Ra-226) in voles (M. pennsylvanicus) established on uranium tailings and have suggested that these animals could possibly be used as a biomonitoring species (10,11). The present paper explores this idea further and suggests the use of various small mammalian species for monitoring radionuclide levels in the environment near uranium tailings and open pit uranium mines.

DISCUSSION

Past and continuing mining and milling of uranium ores have left large quantities of tailings on the surface. Environmental regulations require that these wastes, containing elevated levels of transuranium series radionuclides, be stabilized in order to prevent the migration of undesirable materials away from the waste disposal areas. Mining companies in the Elliot Lake area have, at the present, stabilized most of their inactive uranium tailings by establishing a lush vegetation cover.

Revegetation of tailings has made the waste sites attractive to neighbouring indigenous species of plants, invertebrates and vertebrates (i.e. small mammals) which have, therefore, established themselves in these ecosystems. The extent and subsequent effects of bioaccumulation of radionuclides in those species are unknown and it is believed that the use of a small mammal such as the meadow vole could help in understanding the situation. A study was, therefore, conducted to determine the levels of Ra-226 in the environment and in various tissues of voles established on Nordic uranium tailings (10). Table 1 summarizes the findings of the study.

Table 1 - Ra-226 levels (pCi/g dry weight; n=3) in substrate, vegetation and tissues of meadow voles collected on the Nordic uranium tailings.

Substrate (Tailings)			177 ± 30				
Vegetation (Mixed Species)			9 ± 3				
Total Body of Voles (Summer)			7 ± 3				
Tissues:	G.I. Tract	Skin	Bones	Liver	Kidneys	Muscles	Remaining Tissues
	3	0.6±0.6	38±15	0	0	0	0

Table 1 shows that Ra-226 was accumulated in vegetation and in skeletons of voles feeding on the vegetation established on uranium tailings. Skeletal Ra-226 levels were four-fold higher than those of vegetation and therefore appeared to be a far better indicator of environmental contamination than vegetation. It is, therefore, proposed that radionuclide levels in skeletons of small mammals, such as the meadow vole, could be used for monitoring environmental radionuclide levels.

The development of such a biomonitoring technique would necessitate laboratory experiments designed to measure the percentage retention of Ra-226 in skeletal tissues of small mammals fed various doses of the radionuclide. The effect of age on the percentage retention of Ra-226 would also need to be evaluated. Similar tests could also be performed for other radionuclides such as Pb-210, which is also known to accumulate in vegetation growing on uranium tailings (12,13,14).

It is believed that various sources of environmental pollution, associated with the uranium mining industries, such as wind distribution of contaminated dust around non-stabilized tailings and open pit mines could be monitored by using small mammals. Such a monitoring method is greatly needed in the Northern Saskatchewan area where the harsh climate prevents revegetation programs on inactive uranium tailings from being successful. As a result, the tailings are exposed to wind erosion which could cause considerable contamination around the waste sites as it was demonstrated in the U.S. (15,16). The need for biomonitoring radionuclide levels in the environment is further accentuated by the increase in the number of open pit mines of high grade uranium ore in Canada. Potential contamination of the environment around the open pits by dust resulting from the mining operation and wind erosion of the denuded ground is therefore increased and, as a result, should be monitored.

The deer mouse (Peromyscus maniculatus) and the red-backed mouse (Clethrionomys gapperi) which use forested areas as their habitats, and are found throughout most of Canada, are believed to have an excellent potential for monitoring purposes in forested areas around tailings and open pit mines. Both species feed on seeds and other vegetative matter, insects and other invertebrates and are easy to trap (17).

Because these small mammals have a rather small territory, collection of small mammals at various distances from tailings or open pit mines could show a gradual response to radionuclide uptake and, therefore, could be used to determine the extent and importance of contamination at different distances from the tailings, as with other biomonitoring methods (i.e., lichens). Furthermore, the results could also be used to determine the hazards presented to herbivores feeding in the contaminated areas and to carnivores feeding on the small mammals established in the contaminated areas. This latter information could not be obtained by using conventional biomonitoring species such as lichens.

Other small mammals, such as squirrels and chipmunks, are more difficult to trap and, therefore, do not have a good potential for biomonitoring.

CONCLUSIONS

Extensive revegetation programs conducted on inactive uranium tailings in the Elliot Lake area have been very successful in establishing a permanent lush vegetation cover on most waste sites. These "new" ecosystems are now attractive for neighboring indigenous species of plants, invertebrates and vertebrates which have started to establish on those sites. Questions on the extent, the rate and the hazards of radionuclide bioaccumulation in those

invading species are often encountered and the use of meadow voles as a biomonitoring agent for grassy habitats around and on tailings could, therefore, help to answer some of those questions.

Furthermore, other small mammals inhabiting forested areas (i.e. deer mouse, red-backed mouse) were suggested as potential biomonitoring species to determine the extent of contamination caused by wind erosion of non-stabilized uranium tailings and open pit mines. Therefore, further testing on the percentage retention of radionuclides in various species of small mammals indigenous to the Canadian mining areas is recommended.

REFERENCES

1. Little, P. and Martin, M.H.; Biological monitoring of Heavy Metal Pollution. Environ Pollut, vol 6, pp 1-19; 1974.

2. Johnson, I. and Sochting, V., "Influence of Air Pollution on the Epiphytic Lichenvegetation and bark properties of deciduous trees in the Copenhagen Area." Oikos, vol 24, pp 344-351; 1973.

3. Pilegaard, K., "Airborne Metals and SO_2 Monitoring by Epiphytic Lichens in an Industrial Area"; Environ. Pollut., vol 17, pp 81-92; 1978.

4. Boileau, L.J.R., Beckett, P.J., et al, "Lichens and Mosses as Monitors of Industrial Activity Associated with Uranium Mining in Northern Ontario, Canada, Part 1: Field procedures, chemical analysis and interspecies comparisons"; Environment Pollut (Series B) vol 4, pp 69-84; 1982.

5. Beckett, P.J., Boileau, L.J.R., et al, "Lichens and Mosses as Monitors of Industrial Activity Associated with Uranium Mining in Northern Ontario, Canada, Part 2: Distance dependent uranium and lead accumulation patterns"; Environ Pollut (Series B) vol 4, pp 91-107; 1982.

6. Nieboer, E., Richardson, D.H.S., et al, "Lichens and Mosses as Monitors of Industrial Activity Associated with Uranium Mining in Northern Ontario,

Canada, Part 3: Accumulations of iron and titanium and their mutual dependence"; Environ Pollut (Series b), vol 4, pp 181-192: 1982.

7. Tanaka, J. and Ichikuni, J., "Monitoring of Heavy Metals in Airborne Particles by Using Bark Samples of Japanese Cedar Collected from the Metropolitan Region of Japan"; Atm Environ, vol 16, pp 2015-2018: 1982.

8. Beardsley, A., Vagg, M.J., et al, "Use of the Field Vole (M. agrestis) for Monitoring Potentially Harmful Elements in the Environment"; Environ Pollut, vol 16, pp 65-71; 1978.

9. Rowley, M.H. et al, "Use of Small Mammals (Voles) to Assess a Hazardous Waste Site at Love Canal, Niagara Falls, New York"; Arch Environ Toxicol, vol 12, pp 383-397; 1983.

10. Cloutier, N.R., et al, "Metals (Cu, Ni, Fe, Co, Zn, Pb) and Radionuclide (Ra-226) Levels in Meadow Voles (Microtus pennsylvanicus) Established on Revegetated Copper and Nickel Tailings in Copper Cliff and Uranium Tailings in Elliot Lake"; CANMET Division Report, MRP/MRL 83-53(TR); 1983.

11. Cloutier, N.R., "Metals (Cu, Ni, Fe, Co, Zn, Pb) and Ra-226 Levels in Meadow Voles and Vegetation From Nickel and Uranium Mines Tailings in Northern Ontario"; M.Sc. Thesis, Laurentian University, Sudbury, Ontario; 1984.

12. Moffett, D. and Tellier, N., "Uptake of Radioisotopes by Vegetation Growing on Uranium Tailings"; Can J Soil Sci, vol 57, pp 417-424; 1977.

13. Dave, N.K., et al, "Radionuclide Levels Within Various Tissues of Vegetation Growing on Uranium Tailings in Elliot Lake"; CANMET Division Report, MRP/MRL 84-5 (TR); 1984.

14. Dave, N.K., et al, "Radionuclide Uptake by Various Plants Growing on Uranium Tailings, Elliot Lake, Ontario"; CANMET Division Report, MRP/MRL 84-19 (TR); 1984.

15. Breslin, A.J. and Glauberman, H., "Investigation of Radioactive Dust Dispersal from Uranium Tailings Piles"; Environmental Surveillance in the Vicinity of Nuclear Facilities (W.C. Reinig, Ed.), Thomas, Springfield, Illinois; 1970.

16. Snelling, R.N. and Shearer, S.D., "Environmental Survey of Uranium Mill Tailings Pile, Tuba City, Arizona"; Radiological Health Data and Reports, U.S. Health Service, pp 475-487; July 1967.

17. Peterson, R.L., "The Mammals of Eastern Canada"; Toronto, Oxford Univerity Press, 465 pp; 1966.